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Applicant: (Name and address)
Martin Professional A/S
Olof Palmes Allé 18
DK-8200 Århus N
Denmark

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Susanne Morsing
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PATENT- OG VAREMÆRKESTYRELSEN

The present invention relates to an apparatus for projecting at least a first light beam onto a target, which apparatus comprises means for controlling the power of the light beam, which light source emits coherent radiation in the visible and the invisible light spectrum. The present invention also relates to a method for operation of a light beam, which light beam is operated in a public room.

US 5.451.765 describes an improved eye safety protection system for laser systems. The present invention measures energy returned along the optical axis itself. A beam splitter is installed in the optical axis, and it intercepts reflected energy back along the optical axis and passes the reflected energy to a photo detector which is used to measure the light scattered or reflected back along the emitting axis from the beam splitter. The output from the detector is passed to a comparator and regulation unit, which adjusts the power level in the primary energy beam. Outgoing power can also be monitored by use of the same detector.

By measuring reflected energy from a surface, only a very poor indication of the actual power level on the surface can be achieved. The colour of the surface has a major influence on the received and the reflected power level. If the surface is a poor reflector, the laser beam can be adjusted to an unsafe power level. By combining a part of the emitted light and a part of the reflected light in a common photo detector, the colour of the reflecting surface still has a major influence on the laser power. Another problem can be the speed of regulation. If a laser beam with a high power level is indicated, the laser light has hit a target before regulation starts. A feedback system often comprises a delay for reduction of oscillations; this can lead to a high power level for several microseconds. The invention described above is dangerous if it is used in a public room as there is a risk of humans being hit by the laser light beam.

US 4,449,043 describes an optical power source control system having a four port optical coupler, an optical receiver ~~and~~ associated comparator circuits operably connected to the optical transmission line connecting the source to an output connector. When the output connector is mated with another connector, the receiver senses the optical energy reflected from the glass/air and air/glass interfaces of the connectors and provides an appropriate signal. This signal is sufficiently high when compared to a

threshold voltage level to permit the power source to operate. When the output connector is in the unmated condition, the reflected optical power from the air/glass interface is no longer present, and, therefore, the signal from the receiver falls below the threshold voltage level. With this reduced signal level, the power flow to the optical source is removed or reduced and, thereby, it controls the operation of the optical power source.

GB 2249164 A describes an illumination lamp apparatus comprising a laser-scanning device. Safety cut-out devises are provided in order to ensure that the laser light beam is not pointed at the audience or the performers. The apparatus comprises a computerised control apparatus comprising software to monitor the direction of the beam and cut it in when it points in prohibited directions. Pointing the light beam towards humans is not mentioned in the document.

The scope of this invention is to increase safety for people subjected to a light beam so people can be subjected to the light beam with no risk. for eye or skin or for other medical indications, which might be physical or mental.

This can be achieved with an apparatus comprising detecting means for detecting the power content of the light beam, which apparatus also comprises means for reducing the light power, which means for reducing light power is activated if the power content of the light beam increases to above a defined value.

Light systems can be used in the entertainment industry because the maximum power level of the light beam can be controlled within a security class for safety, e.g. class 3R. If the power level of the light beam is inside the level of the safety class, the light beam can hit people without the risk of damaging the body or eye or for other medical indications, which might be physical or mental.

Preferably the light generating means can be a laser, which laser can generate a well-defined light beam. The power content of a light beam generated by a laser can be harmful to humans so the power of the light beam has to be controlled within a security class.

The detection means can detect the power transmitted to a target area by internal analyses of the light beam during operation of the light. By calculating the light beam power in a target area, it would be possible even over longer distances to transmit light to the target area in a way where the maximum power of the light beam in the target area is below a defined security class. This way, the light beam can be used in the target area without the risk of hitting people.

The detection means detects the power transmitted to an imaginary target area by internal analyses of the light beam during operation, which imaginary target area is placed in a first defined distance from the apparatus. By using an imaginary target area, e.g. in a distance of two meters in front of the light apparatus, the power of the light beam can be adjusted in a way so that the power content in a distance above the imaginary target will be below the security class. This way, a light beam can be operated for example over a stage if just the light apparatus is placed sufficiently high above the floor level.

The apparatus can comprise two axis light beam deflective means for scanning a target. The use of deflective means, makes it possible to scan a large area with a light beam, and for the entire area, the maximum power level of the light beam can be controlled to be below a defined security level.

The detection means detects the number of points produced by a scanning frequency where the light power is calculated for each single radiated point. In this way where every single radiated point is calculated by the detection means, the entire area and each single pixel that is being exposed to the light are under control, and the power of the light beam is reduced to below the security level.

The apparatus can comprise a feedback circuit where input to the feedback circuit is connected to the detection means, which feedback circuit contains an output connected to a modulation input to a light power supply. By the direct connection between the detection means that calculates the power content of the light beam and delivers this signal for the modulation of the input to the light power supply, the power of the light beam can be controlled and in this way be below a defined security level.

The apparatus might also contain a distance measuring device, which distance measuring device emits a second electromagnetic beam, and which distance measuring device contains at least one optical receiver for detecting the actual distance to an object, which apparatus comprises means for reducing the power of the light beam where the power content of the light beam is reduced if a target is detected closer to the apparatus than a first defined distance. In this way, it might occur that even if the maximum power level of the light beam is controlled to be below a security level, there is always the risk that people move into the light closer to the light apparatus than expected. In this way, the extra distance measuring function can reduce the power of the light beam to an acceptable security level even very close to the light.

The light beam can be deactivated if an object is detected closer to the apparatus than the first defined distance. Moreover, the light can be shut off if an object is detected inside a security zone in front of the light.

The power of the light beam can be controlled by power calculating means, which calculating means controls the light output power, which light output power is reduced to a defined safety level. In this way, it can be achieved that a light always will be operated with a power content of the light beam that is below the defined security level.

The method can comprise a computer and a program, which program can comprise mathematical calculations regarding a number of points in graphic settings. Hereby, it can be achieved that the power level in each point hit by the light beam is inside a safety level.

The method can also comprise a computer and a program, which program can comprise mathematical calculations regarding a number of points in scan rate settings. Hereby, it can be achieved that the power level of the light beam in every scan rate setting is inside a safety level.

The method can also comprise a computer and a program, which program can comprise mathematical calculations regarding a number of points in size settings. Hereby,

it can be achieved that the power level of the light beam in a number of points in size setting is inside a safety level.

The method can comprise a computer and a program, which program can comprise mathematical calculations regarding a number of points in modulation settings. Hereby, it can be achieved that the power level of the light beam in every modulation setting is inside a safety level.

The computer and the program can, continuously, supervise changes, in settings of graphic, size, scan rate and modulation. By using input from the different parameters and their changes, the power level of the light can be supervised.

The computer and the program can continuously supervise and adjust the power level of the laser and the light beam. Hereby, it is achieved that the power level of the light beam is always inside a safety level.

In the following, the invention is described with reference to the drawing, where

fig. 1 shows a first schematic diagram over one possible apparatus according to this invention,
fig. 2 shows a top view of a second possible apparatus according to this invention,
fig. 3 shows the same apparatus as fig. 2 but in front view,
fig. 4 shows the same apparatus according to the invention but now seen in a three-dimensional view.

Fig. 1 shows an apparatus 2 generating a light beam 4 that hits a target 6. The light beam 4 is generated by light generating means 8 which could be in the form of a laser device. The light generating means 8 is connected to light power reduction means 10, and calculation means 12 is calculating the power of the light beam 4. An imaginary target area 14 is placed in a first defined distance in front of the apparatus 2. Actuators 16,18 are connected to a mirror 17, and the light beam 4 can be swept over the target 6 and the imaginary target 14. The actuators 16,18 are electrically connected to the analysing means 12 by electrical connection means 19. Connecting means 22 connects

feedback means 20 to the calculation means 12. By connection means 24, the feedback circuit 20 is connected to the light power reduction means 10, which is connected by connection means 25 to the light generating means 8. The apparatus further comprises a means for distance measuring 26,30, which means for distance measuring comprises generation means 26 for generation of a second electro-magnetic beam 28, which beam is detected by a detector 30 where the actual distance to the object 32 can be achieved.

Inside the apparatus 2, the light beam 4 might be reflected several times by hitting different mirrors, but in this primitive sketch, a first fixed mirror 40 is used, from which, the light beam 4 is directed towards the movable mirror 17, and from here the light beam is reflected directly towards the target 6.

In operation, the detection means 12 will be based on input over the line 19 from the actuators 16,18 and may by further inputs to the detection means 12 make it possible to analyse the total energy contents at every point that is hit by the light beam 4. By using the connection 22 from the detection means 12, the feedback circuit 20 can communicate towards the light reduction means 10, and the energy contents of the light generating means 8 can be controlled continuously. This control can be done without any measurement of the light, and the energy contents of the light that hit the target can be reduced to a level below the limit of a safety class. In this way, the power content of the light beam might be increased on the distance from the apparatus and to the target 6. Further safety is achieved by using the extra distance-measuring means 26,30 because it will be able to indicate objects that are moving in front of the target, and that may be closer to the apparatus than calculated. If this happens, the power of the light beam 4 can be reduced immediately or if an object 32 may be closer than two meters to the apparatus, the light beam can be shut down :mmediately.

Fig. 2 shows a top view of an alternative embodiment of the invention. Fig. 2 shows an apparatus 102 comprising light generating means 108. Actuators 116,118 are connected to a not shown movable mirror. Distance measuring devices 126,130 are shown at the top. A fixed mirror 140 is indicated where also a front window 142 is shown. Inside the apparatus, shutting means 144 are shown connected to an actuator 145. This

actuator 145 and the shutting means 144 are able to interrupt the light beam in case of an emergency. A printed circuit board 146 contains different electronic modules, which are described with reference to fig. 1.

Fig. 3 shows the apparatus 102 seen from the front side. Light generating means 108 is shown, and also actuators 116, 118 can be seen from the front. These actuators are connected to a movable mirror 117. Also the fixed mirror 140 is shown. The front window 142 is also seen from this view where also the shutting means 144 can be seen.

Fig. 4 shows the same apparatus 102 but seen in a three-dimensional view. The light generating means 108 is seen. Also the actuator 116 can be seen from the front side. This actuator 116 is connected to the mirror 117, which is partly seen through the window 142. Over the mirror 117, the extra distance measuring means 126,130 are seen. Also the fixed mirror 140 can be seen, and over this mirror 140, interruption means 144 activated by the actuator 145 is seen. Also the printed circuit board 146 is seen on fig. 4.

In practical use of an apparatus as described in fig. 2, 3 and 4, it can be achieved that the energy contents of a light beam generated by a laser always at a target will be inside for example the safety class 3R.

Fig. 5 is a flow chart over the different functions that take place during operation in an apparatus as described in fig. 1-4.

Flowchart explanation:

1. Select graphic offset
2. Select size offset
3. Select scan rate offset
4. Select modulation offset
10. Check for graphic change (y/n)
11. Check for size change (y/n)
12. Check for scan rate change (y/n)

13. Check for modulation change (y/n)
14. Rescan
20. Graphic is selected by user
21. Graphic selection timeout 100µs is selection finished (y/n)
22. Graphic is correct – Apply mathematical calculation regarding to number of points in new graphic settings to existing scan rate, size and modulation.
23. Adjust power level on Laser PSU
30. Size is selected by user
31. Size selection timeout 100µs is selection finished (y/n)
32. Size is correct – Apply mathematical calculation regarding to number of points in new graphic settings to existing scan rate, size and modulation
33. Adjust power level on Laser PSU
40. Scan rate is selected by user
41. Scan rate selection timeout 100µs is selection finished (y/n)
42. Scan rate is correct – Apply mathematical calculation regarding to number of points in graphic to new scan rate settings, size and modulation
43. Adjust power level on Laser PSU
50. Modulation & rate is selected by user
51. Modulation selection timeout 100µs is selection finished (y/n)
52. Modulation is correct – Apply mathematical calculation regarding to number of points in graphic to scan rate, size and new modulation settings.
53. Adjust power level on laser PSU

CLAIMS

1. Apparatus (2, 102) for projecting at least a first light beam (4, 104) onto a target (6, 106), which apparatus (2, 102) comprises light generating means (8, 108), which light generating means (8, 108) are connected to controlling means (10, 110) for controlling the power of the light beam (4, 104), which light generating means (8, 108) emits coherent radiation in the visible and the invisible light spectrum, **c h a r a c t e r i s e d** in that the apparatus (2, 102) comprises calculation means (12, 112) for calculation of the power content of the light beam (4, 104), which apparatus (2, 102) comprises means (10, 110) for reducing the light power, which means (10, 110) for reducing the light power is activated if the power content of the light beam (4, 104) increases over a defined value.

2. Apparatus according to claim 1 **c h a r a c t e r i s e d** in that the light generating means (8, 108) comprises a laser.

3. Apparatus according to claim 1 or 2 **c h a r a c t e r i s e d** in that the analysing means (12, 112) detects the power transmitted to a target (6, 106) area by internal analyses of the light beam (4, 104) during operation of the light beam (4, 104).

4. Apparatus according to any one of the claims 1-3 **c h a r a c t e r i s e d** in that the analysing means (12, 112) detects the power transmitted to an imaginary target area (14, 114) by internal analyses of the light beam (4, 104) during operation of the light generating means (8, 108), which imaginary target area (14, 114) is placed in a first defined distance from the apparatus (2, 102).

5. Apparatus according to any one of the claims 1-4 **c h a r a c t e r i s e d** in that the apparatus (2, 102) comprises a two-axis light beam deflective means (16, 18, 116, 118) for scanning a target (6, 14, 106, 114).

6. Apparatus according to any one of the claims 1-5 **c h a r a c t e r i s e d** in that the detection means (12, 112) detects the number of points produced by a scanning fre-

quency. where the light beam (4, 104) power is calculated for each single radiated point.

7. Apparatus according to any one of the claims 1-6 **characterised** in that the apparatus (2, 102) comprises a feedback circuit (20, 120), where input (22, 122) to the feedback circuit (20, 120) is connected to the detection means (12, 112), which feedback circuit (22, 122) contains an output connected to a modulation input (24, 124) at the light reduction means (10, 110) which is further connected to the light generating means (8, 108).

8. Apparatus according to any one of the claims 1-7 **characterised** in that the apparatus (2, 102) contains a distance measuring device (26, 126), which distance measuring device emits a second electromagnetic beam (28, 128), which distance measuring device contains at least one electromagnetic receiver (30, 130) for detecting the actual distance to an object (32, 132), which apparatus comprises means for reducing the power of the light beam (4, 104), where the power content of the light beam (4, 104) is reduced if an object (32) is detected closer to the apparatus (2) than a first defined distance.

9. Apparatus according to claim 8, **characterised** in that the light beam (4, 104) is deactivated if an object (32, 132) is detected closer to the apparatus (2, 102) than the first defined distance.

10. Method for operation of a light beam (4, 104), which light beam (4, 104) is operated in a public area, **characterised** in that the power of the light beam (4, 104) is controlled by power calculating means (12, 112) which calculating means (12, 112) is controlling the output power of the light beam (4, 104). which light output power is reduced to a defined security level.

11. Method according to claim 10. **characterised** in that the method comprises a computer and a program, which program comprises mathematical calculations regarding a number of points in graphic settings.

12. Method according to claim 10, **c h a r a c t e r i s e d** in that the method comprises a computer and a program, which program comprises mathematical calculations regarding a number of points in scan rate settings.

13. Method according to claim 10, **c h a r a c t e r i s e d** in that the method comprises a computer and a program, which program comprises mathematical calculations regarding a number of points in size settings.

14. Method according to claim 10, **c h a r a c t e r i s e d** in that the method comprises a computer and a program, which program comprises mathematical calculations regarding a number of points in modulation settings.

15. Method according to claim 11- 14, **c h a r a c t e r i s e d** in that the computer and the program, continuously, supervise changes in settings of graphic, size, scan rate, and modulation.

16. Method according to claim 10-15, **c h a r a c t e r i s e d** in that the computer and the program, continuously, supervise and adjust the power level of the laser and the light beam.

ABSTRACT

The present invention relates to an apparatus and a method for projecting at least a first light beam onto a target, which apparatus comprises means for controlling the power of the light beam, which laser emits coherent radiation in the visible and the invisible light spectrum, which light beam is operated in a public room. The scope of this invention is to increase safety for people subjected to a light beam so people can be subjected to the light beam with no risk for eye or skin. This can be achieved with an apparatus and a method comprising detecting means for detecting the power content of the light beam, which apparatus also comprises means for reducing the light power, which means for reducing the light power is activated if the power content of the light beam increases to above a defined value. Light systems can be used in the entertainment industry, because the maximum power level of the light beam can be controlled into a security class for safety, e.g. class 3R. If the power level of the light beam is inside the level of the safety class, the light beam can hit people without the risk of damaging the body or eye or other medical indications, which might be physical or mental.

(Fig. 1)

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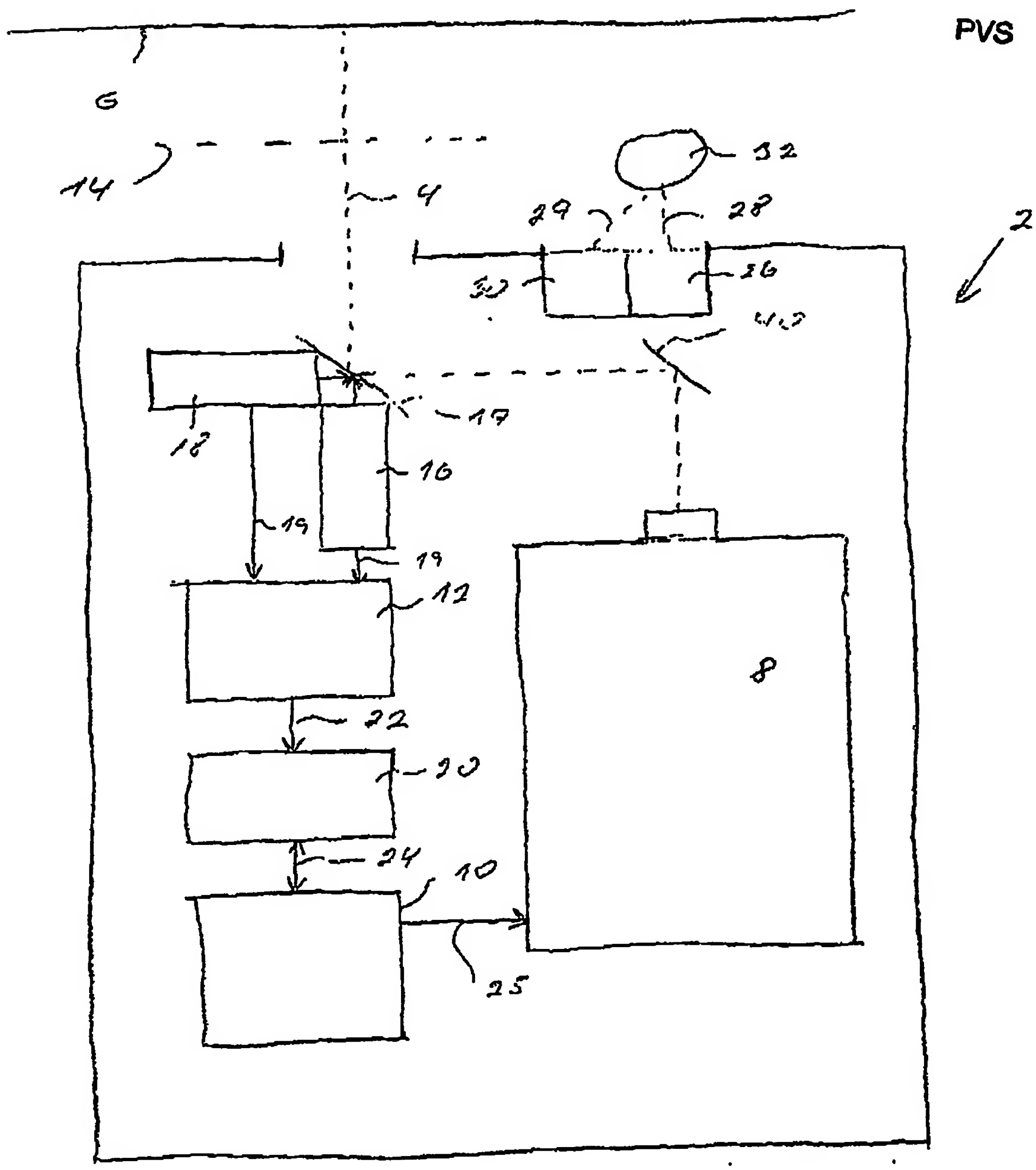
Fig. 1



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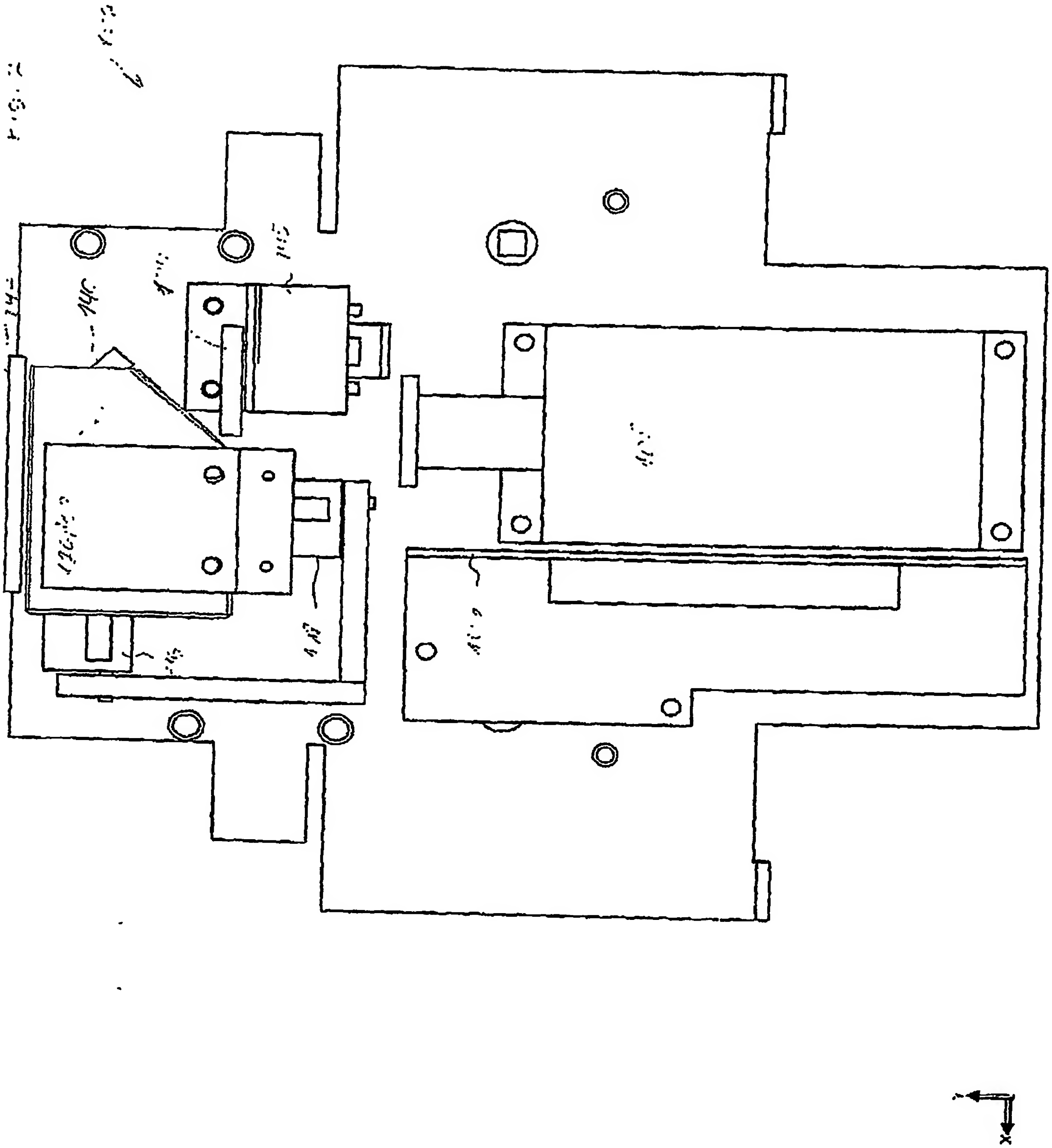

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Fig. 3

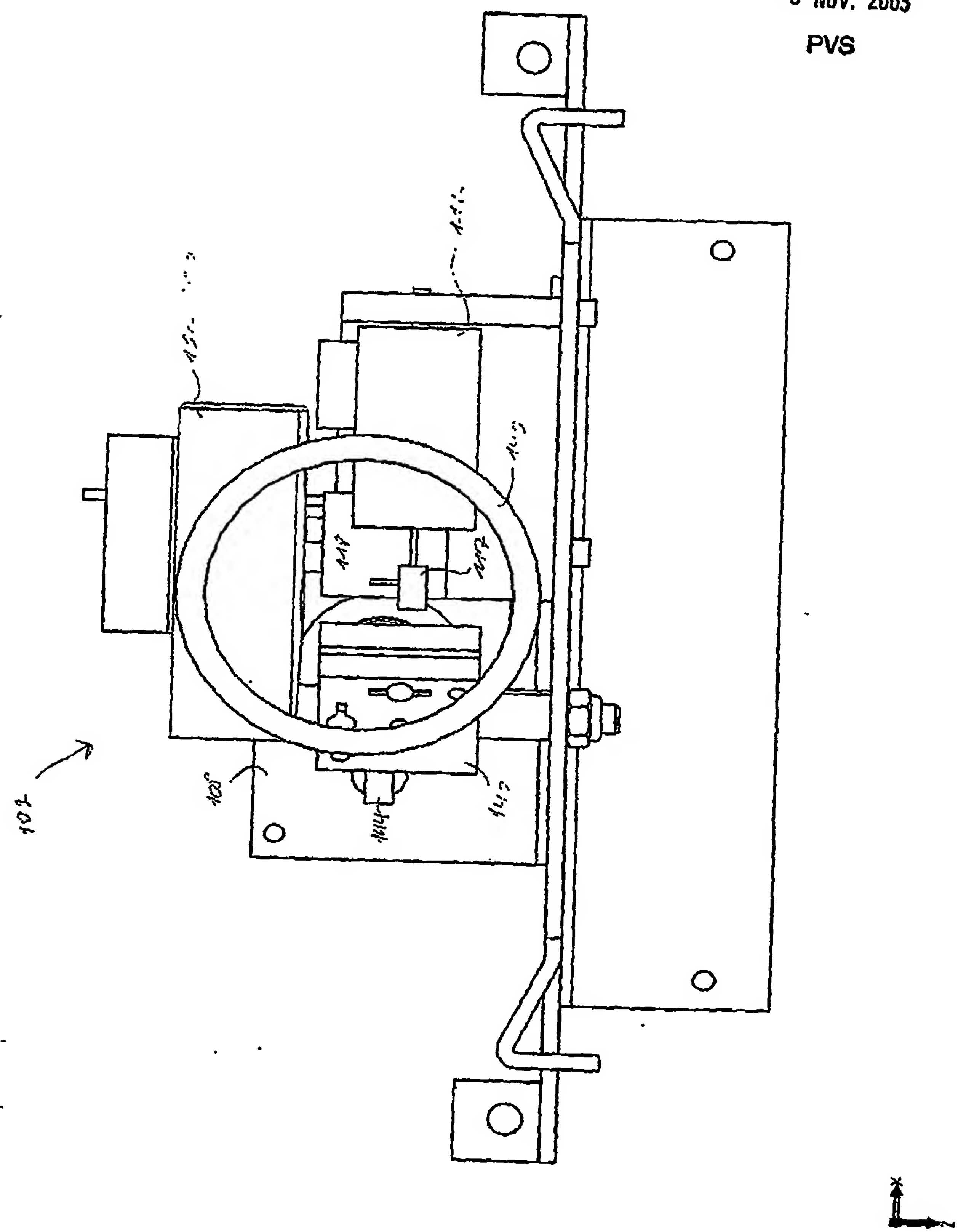
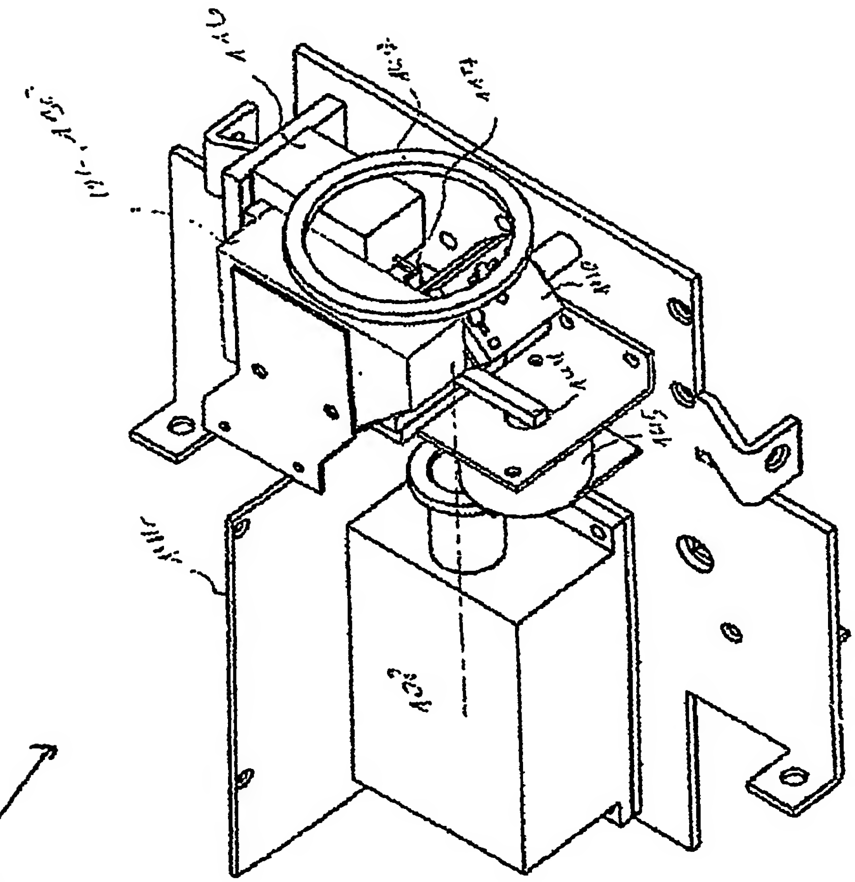


Fig.



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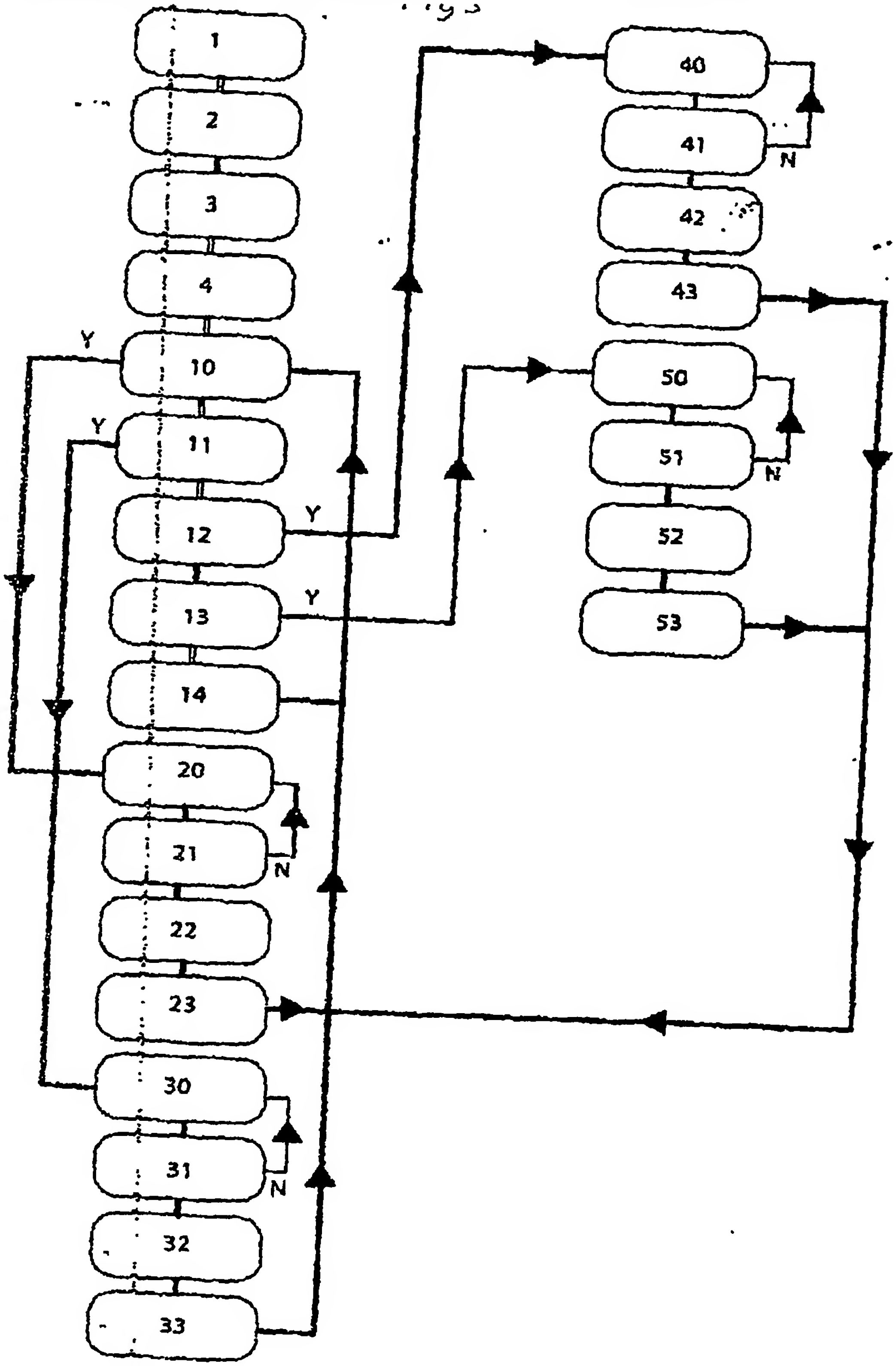

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